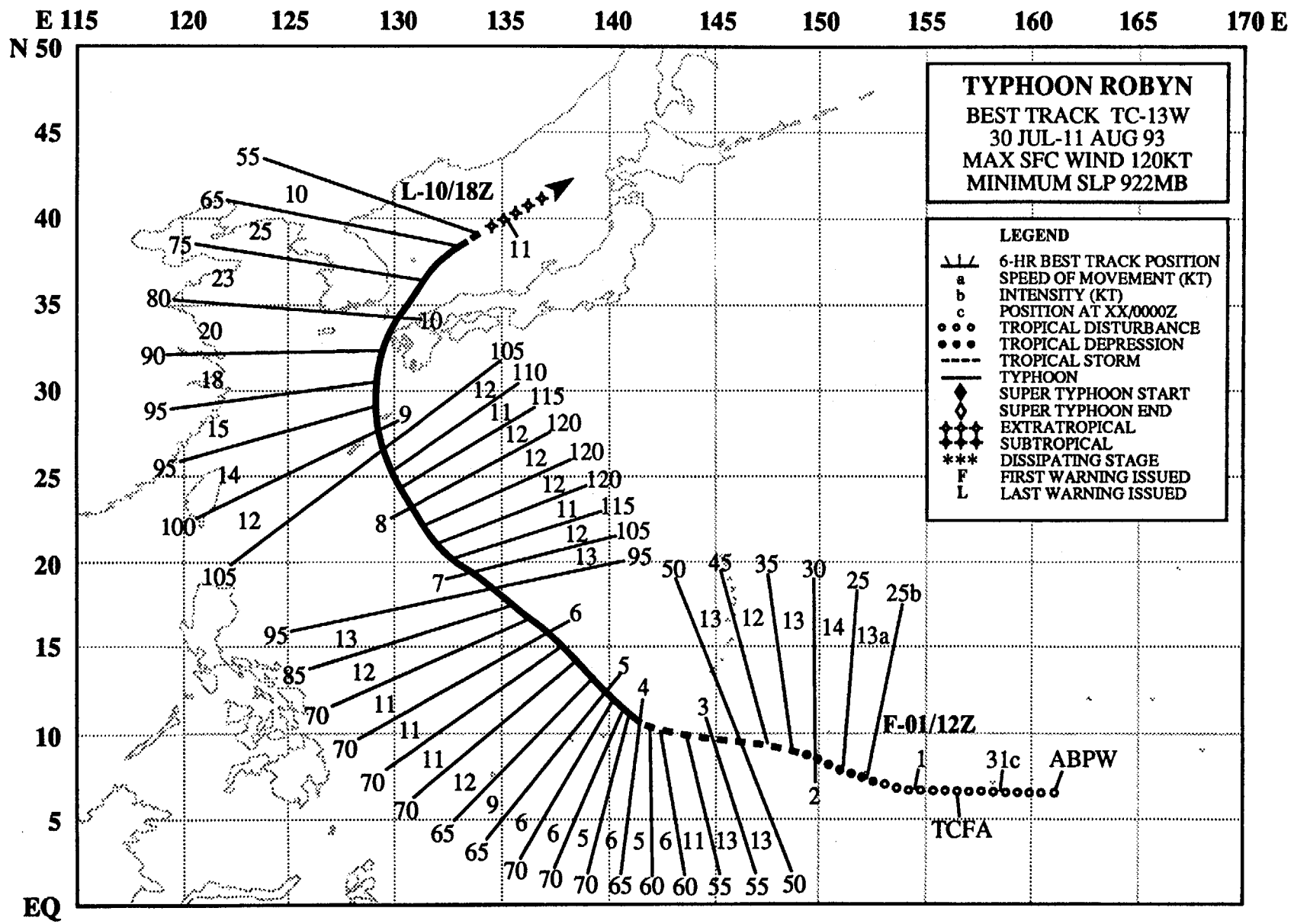
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EQ
TYPHOON ROBYN
BEST TRACK TC-13W
30 JUL-11 AUG 93
MAX SFC WIND 120KT
MINIMUM SLP 922MB
LEGEND
6-HR BEST TRACK POSITION
a SPEED OF MOVEMENT (KT)
b INTENSITY (KT)
c POSITION AT XX/0000Z
TROPICAL DISTURBANCE
TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON
SUPER TYPHOON START
SUPER TYPHOON END
EXTRATROPICAL
SUBTROPICAL
*** DISSIPATING STAGE
F FIRST WARNING ISSUED
L LAST WARNING ISSUED
L-10/18Z
F-01/12Z
TCFA
ABPW
31c
25b
13a

TYPHOON ROBYN (13W)

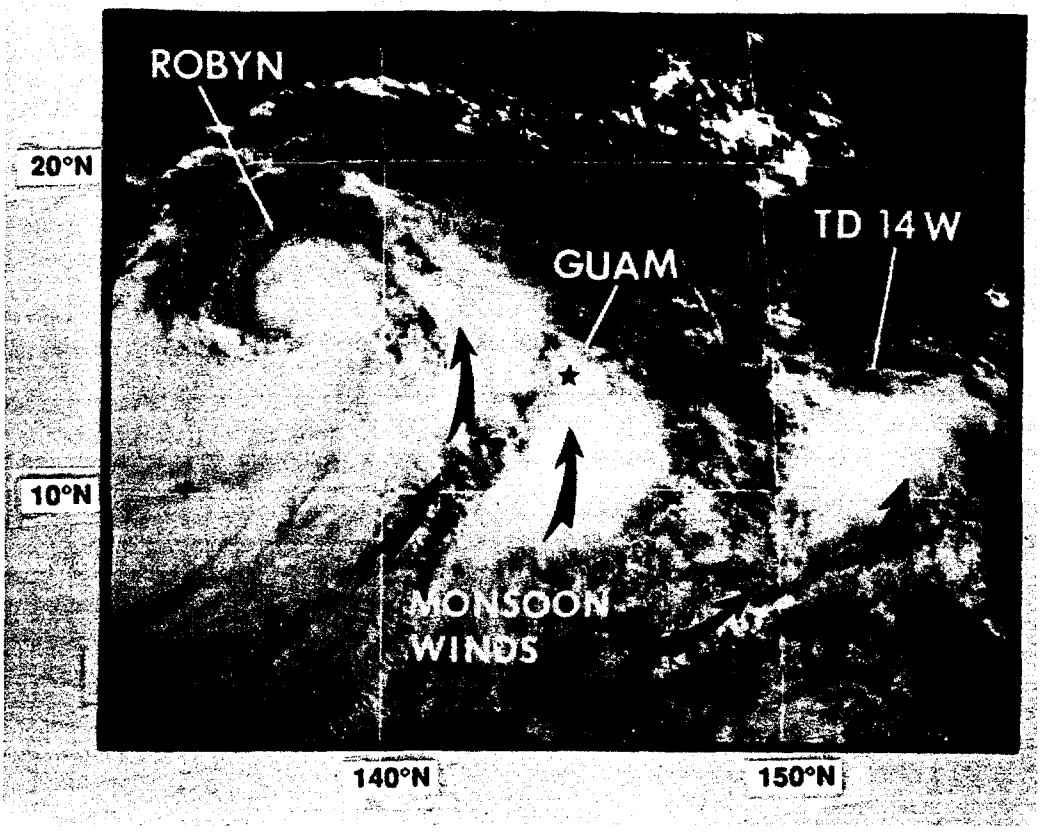

Figure 3-13-1 Typhoon Robyn with its associated rain and monsoon southwesterly winds churns northwestward towards Ryukyu Islands (052224Z August visual GMS Imagery).

I. HIGHLIGHTS

The sixth and final tropical cyclone of July, Robyn, formed in the near equatorial trough in the eastern Caroline Islands. This typhoon was notable for its large size, and for the fact that it was one of three to impact both Okinawa and Sasebo, Japan in 1993. Data from a WC-130 weather reconnaissance aircraft flying in support of TCM-93 were used to support tracking and forecasting.

II. CHRONOLOGY OF EVENTS

July

300600Z - An area of persistent convection in the near equatorial trough resulted in the first mention of the disturbance in the Significant Tropical Weather Advisory..

311300Z - A Tropical Cyclone Formation Alert was issued based on indications from animated satellite imagery, synoptic reports and weather reconnaissance observations that a cyclonic circulation was developing.

August

011200Z - The first warning was issued based on a satellite intensity estimate of 25 kt (13 m/sec).

020600Z - Based on a satellite intensity estimate of 35 kt (18 m/sec), Robyn was upgraded to a tropical storm, about 250 nm (463 km) northwest of Chuuk.

030600Z - Based on a satellite intensity estimate of 65 kt (33 m/sec), Robyn was upgraded to a typhoon.

Post analysis of subsequent satellite and aircraft data indicated that the system most probably reached typhoon intensity at 040000Z.
080835Z - The JTWC transferred warning responsibility for Robyn to the AJTWC at Pearl Harbor, Hawaii after an 8.1 magnitude earthquake centered near Guam interrupted power and communications at JTWC.
082130Z - The JTWC resumed warning responsibility.
101800Z - The final warning was issued on Robyn as it rapidly weakened and transitioned into an extra-tropical low.

III. IMPACT

As Robyn moved southwest of Guam, it provided some relief for the drought-stricken island. Typhoon Robyn caused Condition of Readiness (COR) 1 to be set at Ulithi and Yap. JTWC forecasters expected the system to turn northward, but that the timing could not be determined accurately enough to keep Yap from setting COR 1. After passing to the north of Ulithi and Yap, Robyn (Figure 3-13-1) headed for the Ryukyu Islands. Kadena AB, on Okinawa evacuated aircraft and went to COR 1 at 080300Z. Peak winds recorded on Okinawa were 43 kt (22 m/sec). Subsequently, Robyn tracked across Kyushu, causing the Naval Station at Sasebo, Japan to set COR 1. As Robyn passed just west of the Sasebo, a ship in the harbor, the MV Maersk Constellation, reported sustained winds of 60-65 kt (31-33 m/sec) and a barometric pressure of 973 mb at 091800Z. The ship's pressure fell to a minimum of 969.0 mb at 092200Z. During the ordeal, the ship dragged anchor for half a mile across the harbor. In contrast, the Sasebo weather station which is sheltered by hills only reported maximum sustained winds of 40-48 kt (21-25 m/sec) with gusts to 60 kt (31m/sec). Later, as Robyn passed though the Korea Strait, it created 20-35 ft (6.1-10.7 m) waves on the southern coast of Korea. Coastal wave damage and agricultural losses due to flooding amounted to more than (US)$68 million. Of the over 45 storm-related deaths, press reports indicated 39 resulted from automobile accidents attributed to the torrential rains.

IV. DISCUSSION

The JTWC-based, month-long TCM-93 was in progress when Robyn began developing. The experiment team was using a WC-130 weather reconnaissance aircraft to test hypotheses involving sub-synoptic and mesoscale effects on tropical cyclone motion. In the case of Robyn, the team planned to test the hypothesis of Holland and Lander (H&L) (1993) that large mesoscale convective systems (MCS) embedded in the tropical cyclone circulation can cause meanders in tropical cyclone tracks on the order of 100 km over a period of 1-2 days. H&L's physical explanation for this is that an MCS develops sufficient vorticity, allowing it to rotate cyclonically with the tropical cyclone about a centroid between the two, in a manner similar to that observed during a Fujiwhara (or binary) interaction between two independent tropical cyclones. At 1230Z on the night of 03 August, a band of convection began to build about 100 nm (185 km) north of Robyn's central dense overcast (CDO). In two hours, a portion of the band had explosively expanded into a large elliptical MCS of comparable size to Robyn's CDO (Figure 3-13-2). Over the 9-hour period from 031500Z to 040000Z, the large MCS rapidly moved 300 nm (555 km) westward (from an initial location to the north of Robyn to a later position to the northwest of Robyn), at a speed of 34 kt (63 km/hr). During the same 9-hour period, Robyn slowed in forward speed from 13 kt (24 km/hr) to 6 kt (11 km/hr). After the MCS moved to the west side of Robyn, the typhoon's track, at least in the animated satellite imagery, appeared to cease all westward movement, take a small dip to the south, and then reverse direction, heading to the north and then the northwest.

This abrupt track change required less than 6 hours. The sequence of events concerning Typhoon Robyn are discussed in more detail in Harr et. al (1993).

Another plausible explanation for the unusual motion of Robyn has been postulated by Carr and Elsberry (C&E) (1994), who attributed the behavior to the interaction of Robyn with a large "monsoon gyre" located to its west. In sensitivity studies using a barotropic model, C&E were able to duplicate the character of Robyn's abrupt track changes — westward motion followed by an abrupt change to northward or northwestward motion. Figure 3-13-3 illustrates the sudden track changes exhibited by 6 tropical cyclones in 1990. It is conceivable that both the MCS and monsoon gyre mechanisms may have been working in tandem to produce Robyn's abrupt track change.

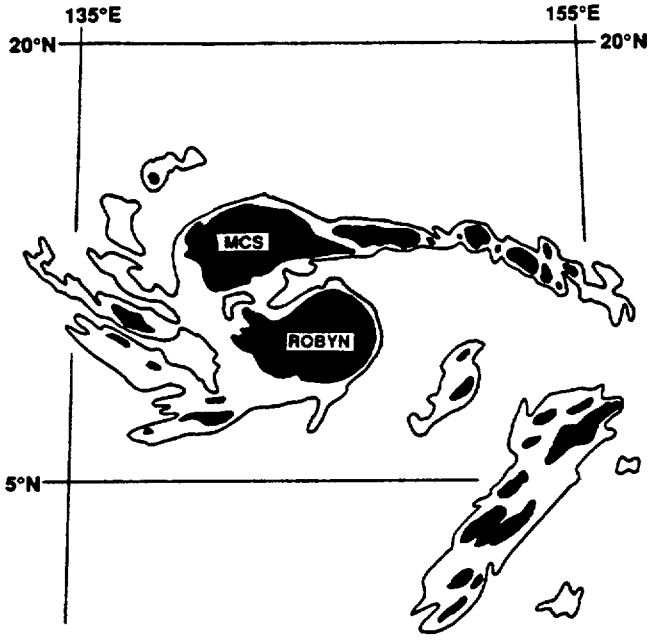

Figure 3-13-2 Graphic representation of the observed cold cloudiness associated with Robyn's CDO and an MCS. Solid black cloud silhouettes represent areas of coldest convective tops, outer contours shows regions of dense cirrus overcast. (Adapted from 031531Z August enhanced infrared GMS imagery.)

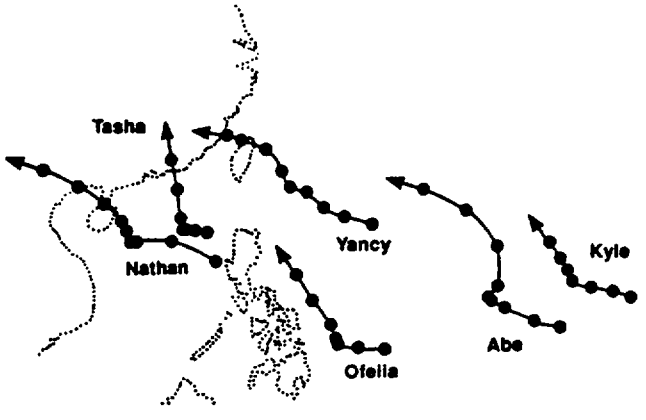

Figure 3-13-3 A composite of 3-4 day track segments centered around sudden below-the-ridge track changes for 6 tropical cyclones in 1990 (from Carr and Elsberry, 1994).